

CLAIMS

1. A digital signal encoding apparatus for encoding one-bit signals of a plurality of n ($n \geq 2$) channels, the one-bit signals being modulated in the delta-sigma manner, comprising:

means for phase-modulating the one-bit signals as original signals to add data of inverted phases thereto; and

means for adding information data which is related with the one-bit signals to the phase-modulated one-bit signal data having the data of inverted phases added thereto by rearranging the data of inverted phases on the basis of a plurality of m ($n \geq m \geq 2$) channel unit of the n channels.

2. The digital signal encoding apparatus as set forth in Claim 1, wherein the information data adding means rearranges the data of inverted phases by employing an exclusive OR of the information data and the phase-modulated one-bit signal data.

3. The digital signal encoding apparatus as set forth in Claim 2, wherein, in case the m is 2 and two-bit data of the phase-modulated one-bit signal data is [0, 1] or [1, 0], the information data adding means rearranges the data of inverted phases in accordance with the information data.

4. The digital signal encoding apparatus as set forth in Claim 3, wherein, in case the information data is [1], the information data adding means rearranges the data of inverted phases.

5. The digital signal encoding apparatus as set forth in Claim 1, further comprising

synchronization signal adding means for adding independent synchronization patterns which cannot exist in the phase-modulating means or in the information data adding means by arranging a region of a plurality of samples other than a region to which the information data is added in the phase-modulated one-bit signal data every predetermined period, and converting the data of inverted phases in the region in accordance with the phase-modulated one-bit signal data.

6. The digital signal encoding apparatus as set forth in Claim 5, further comprising correcting means for making the numbers of one-bit data [1]s and one-bit data [0]s in the predetermined period, which are generated when the synchronization patterns are added by the synchronization signal adding means, equal to each other by converting the data of inverted phases in a region of the predetermined period so that the difference between the numbers of [1]s and [0]s becomes zero.

7. A digital signal encoding method for encoding one-bit signals of a plurality of n ($n \geq 2$) channels, the one-bit signals being modulated in the delta-sigma manner, comprising the steps of:

phase-modulating the one-bit signals as original signals to add data of inverted phases thereto;

adding information data which is related with the one-bit signals to the phase-modulated one-bit signal data having the data of inverted phases added thereto by rearranging the data of inverted phases on the basis of a plurality of m ($n \geq m \geq 2$) channel unit of the n channels;

adding independent synchronization patterns which cannot exist in the phase-modulating step or in the information data adding step by arranging a region of a plurality of samples other than a region to which the information data is added in the phase-modulated one-bit signal data every predetermined period, and converting the data of inverted phases in the region in accordance with the phase-modulated one-bit signal data; and

making the numbers of one-bit data [1]s and one-bit data [0]s in the predetermined period, which are generated when the synchronization patterns are added by the synchronization signal adding step, equal to each other by converting the data of inverted phases in a region of the predetermined period so that the difference between the numbers of [1]s and [0]s becomes zero.

8. The digital signal encoding method as set forth in Claim 7, wherein the information data adding step rearranges the data of inverted phases by employing an exclusive OR of the information data and the phase-modulated one-bit signal data.

9. The digital signal encoding method as set forth in Claim 8, wherein, in case the m is 2 and two-bit data of the phase-modulated one-bit signal data is [0, 1] or [1, 0], the information data adding step rearranges the data of inverted phases in accordance with the information data.

10. The digital signal encoding method as set forth in Claim 9, wherein, in case the information data is [1], the information data adding step rearranges the data of inverted phases.

11. A digital signal decoding apparatus for decoding a one-bit data stream transmitted from a digital signal encoding apparatus which phase-modulates one-bit signals as original signals of a plurality of n ($n \geq 2$) channels to add data of inverted phases thereto, the one-bit signals being modulated in the delta-sigma manner, and adds information data which is related with the one-bit signals to the phase-modulated one-bit signal data having the data of inverted phases added thereto by rearranging the data of inverted phases on the basis of a plurality of m ($n \geq m \geq 2$) channel unit of the n channels to generate the one-bit data stream, comprising:

synchronization signal detecting means for self-extracting synchronization signals by detecting independent synchronization patterns which cannot exist in the phase-modulating processing or in the information data adding processing, and are added by arranging a region of a plurality of samples other than a region to which the information data is added in the one-bit data stream every predetermined period and converting the data of inverted phases in the region in accordance with the phase-modulated one-bit signal data;

means for detecting the information data by judging the insertion positions of the data of inverted phases in the one-bit data stream based on the synchronization signals detected by the synchronization signal detecting means; and

means for judging original signal data in the one-bit data stream based on the synchronization signals detected by the synchronization signal detecting means, and detecting the original signal data from leading data of each channel every $2n$ samples.

12. A digital signal decoding method for decoding a one-bit data stream transmitted from a digital signal encoding apparatus which phase-modulates one-bit signals as original signals of a plurality of n ($n \geq 2$) channels to add data of inverted phases thereto, the one-bit signals being modulated in the delta-sigma manner, and adds information data which is related with the one-bit signals to the phase-modulated one-bit signal data having the data of inverted phases added thereto by rearranging the data of inverted phases on the basis of a plurality of m ($n \geq m \geq 2$) channel unit of the n channels to generate the one-bit data stream, comprising the steps of:

self-extracting synchronization signals by detecting independent synchronization patterns which cannot exist in the phase-modulating processing or in the information data adding processing, and are added by arranging a region of a plurality of samples other than a region to which the information data is added in the one-bit data stream every predetermined period and converting the data of inverted phases in the region in accordance with the phase-modulated one-bit signal data;

detecting the information data by judging the insertion positions of the data of inverted phases in the one-bit data stream transmitted from a digital signal encoding apparatus based on the synchronization signals detected by the synchronization signal detecting step; and

judging original signal data in the one-bit data stream transmitted from a digital signal encoding apparatus based on the synchronization signals detected by the synchronization signal detecting step, and detecting the original signal data from

leading data of each channel every $2n$ samples.

13. A digital signal transmitting system, comprising:

a digital signal encoding apparatus which phase-modulates one-bit signals as original signals of a plurality of n ($n \geq 2$) channels to add data of inverted phases thereto, the one-bit signals being modulated in the delta-sigma manner, and adds information data which is related with the one-bit signals to the phase-modulated one-bit signal data having the data of inverted phases added thereto by rearranging the data of inverted phases on the basis of a plurality of m ($n \geq m \geq 2$) channel unit of the n channels to generate a one-bit data stream; and

a digital signal decoding apparatus which self-extracts synchronization signals by detecting independent synchronization patterns included in the one-bit data stream, which cannot exist in the phase-modulating processing or in the information data adding processing, and detects the information data by judging the insertion positions of the data of inverted phases in the one-bit data stream based on the synchronization signals, and judges original signal data in the one-bit data stream based on the synchronization signals and detects the original signal data from leading data of each channel every $2n$ samples.